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**Aissi et al.**

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(54) **SYSTEM AND METHOD FOR USER CERTIFICATE INITIATION, DISTRIBUTION, AND PROVISIONING IN CONVERGED WLAN-WWAN INTERWORKING NETWORKS**

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| ***H04M 1/68*** | (2006.01) |

(Continued)

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CPC ........... ***H04W 12/06*** (2013.01); ***H04L 63/0823*** (2013.01); *H04W 12/04* (2013.01); *H04W 12/08* (2013.01); *H04W 48/16* (2013.01)

(58) **Field of Classification Search**

CPC ..... H04W 12/06; H04W 12/04; H04W 48/16; H04W 76/021; H04W 84/12; H04W 12/08; H04L 63/0823

USPC ............... 455/410, 411, 418, 419, 41.1–41.3, 455/11.1, 556.1, 556.2, 558, 552.1, 553.1; 380/247; 713/155, 156, 168–172, 180, 713/175; 726/10; 370/247–250, 270

See application file for complete search history.

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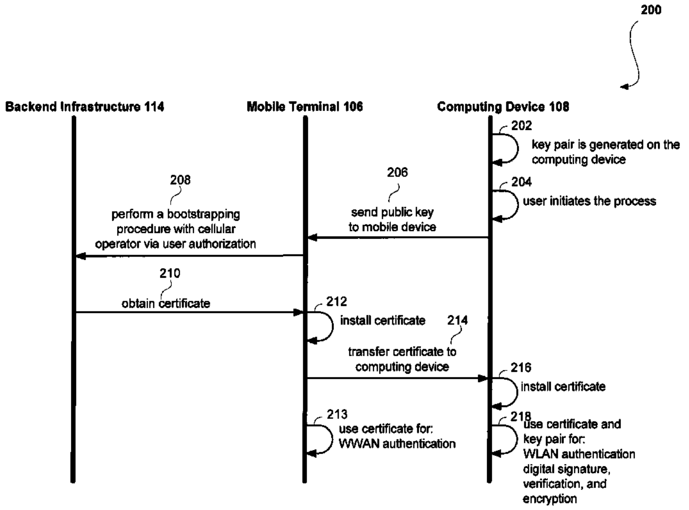
(57) **ABSTRACT**

A system and method for user certificate initiation, distribution, and provisioning in converged WLAN-WWAN interworking networks. A computing device operable in a wireless local area network sends a public key to a mobile device operable in a wireless cellular wide area network. The mobile device performs a bootstrapping procedure with a cellular operator in the wireless cellular wide area network to obtain a user certificate based on the public key. The mobile device sends the user certificate to the computing device for installation on the computing device. The user certificate may be used for digital signature, verification, and encryption purposes. The user certificate is also used in both the wireless local area network and the wireless wide area network for authenticating a subscriber when accessing services from both networks.

**17 Claims, 2 Drawing Sheets**


200
Backend Infrastructure 114
Mobile Terminal 106
Computing Device 108
202
key pair is generated on the computing device
204
user initiates the process
206
send public key to mobile device
208
perform a bootstrapping procedure with cellular operator via user authorization
210
obtain certificate
212
install certificate
214
transfer certificate to computing device
216
install certificate
213
use certificate for: WWAN authentication
218
use certificate and key pair for: WLAN authentication digital signature, verification, and encryption

(51) **Int. Cl.**

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| *H04W 12/04* | (2009.01) |
| *H04W 12/08* | (2009.01) |
| *H04W 48/16* | (2009.01) |

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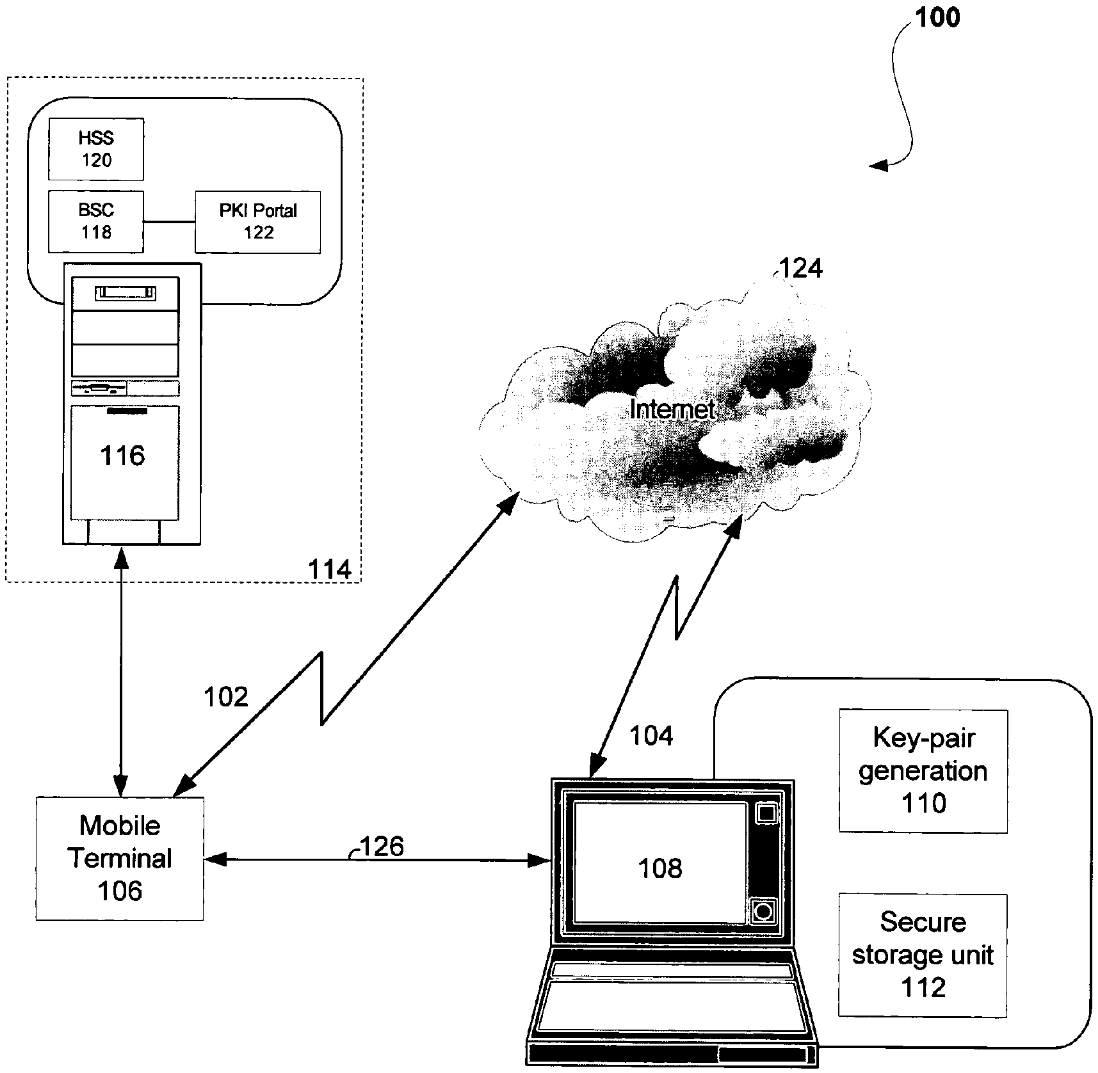
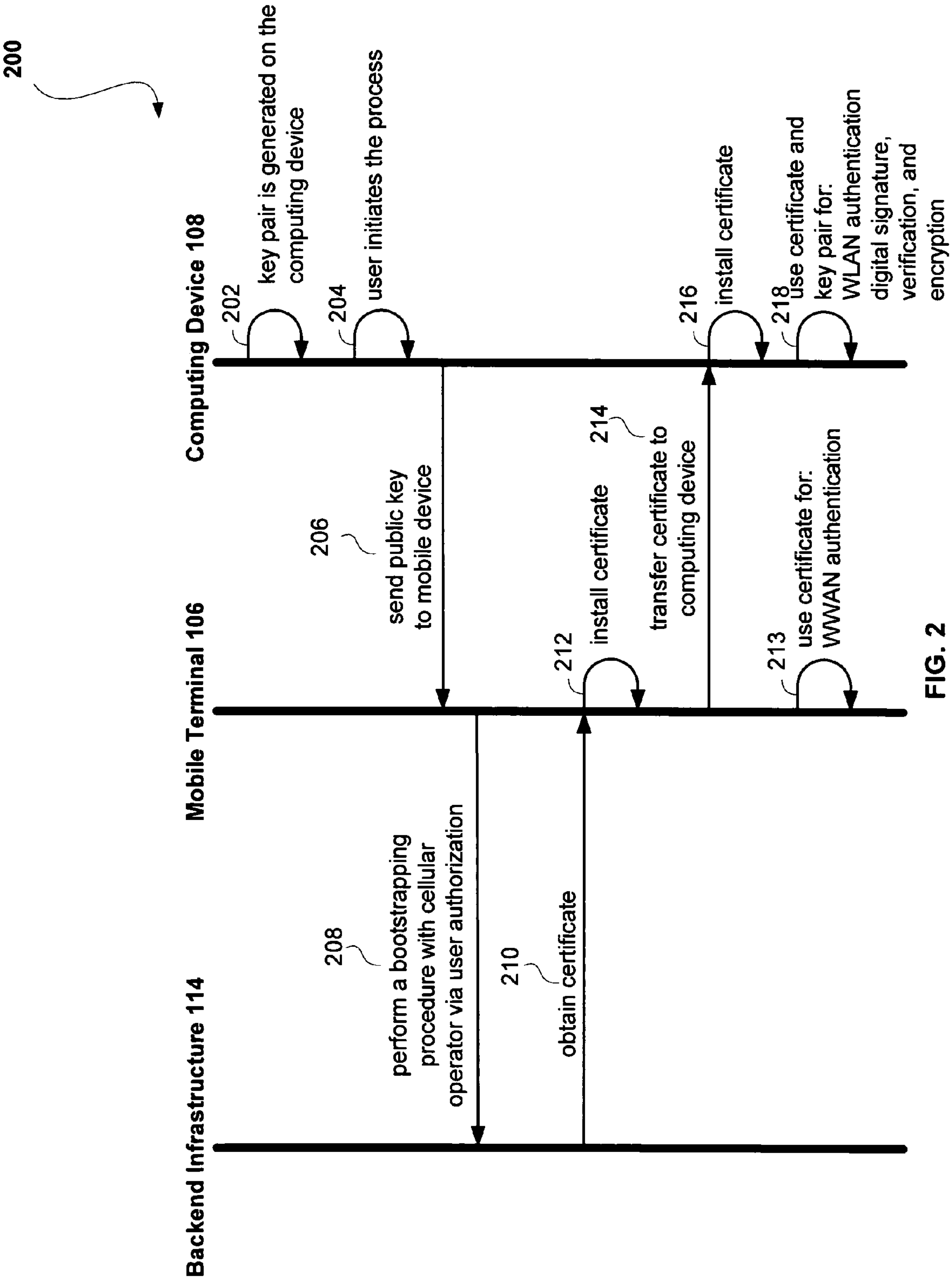

100
HSS
120
BSC
118
PKI Portal
122
116
114
124
Internet
102
104
Mobile
Terminal
106
126
108
Key-pair
generation
110
Secure
storage unit
112

FIG. 1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Backend Infrastructure 114
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210
obtain certificate
212
install certificate
213
use certificate for: WWAN authentication
214
transfer certificate to computing device
216
install certificate
218
use certificate and key pair for: WLAN authentication digital signature, verification, and encryption

FIG. 2

# SYSTEM AND METHOD FOR USER CERTIFICATE INITIATION, DISTRIBUTION, AND PROVISIONING IN CONVERGED WLAN-WWAN INTERWORKING NETWORKS

## BACKGROUND OF THE INVENTION

1. Field of the Invention

Embodiments of the present invention are generally related to the field of WLAN-WWAN (wireless local area network-wireless wide area network) interworking. More particularly, embodiments of the present invention are related to the initiation, distribution, and provisioning of user certificates in converged WLAN-WWAN interworking.

2. Description

Currently, there are various types of wireless networks that are useful for different types of environments. For example, there are wireless wide-area networks (WWANs) and wireless local-area networks (WLANs). WWAN networks may be used for cellular communications, such as, but not limited to, cellular phones and personal digital assistants (PDAs). Example WWAN networks include, but are not limited to, mobile networks such as Global System for Mobile Communications (GSM), Third Generation (3G) of Mobile Communications Technology, and Code Division Multiple Access (CDMA). WLAN networks may be used on computers, such as, but not limited to, laptops, notebooks, workstations, etc. Example WLAN networks include, but are not limited to, 802.11, 802.16, etc.

There are also wireless local links, such as, for example, Bluetooth and Infrared Data Association (IrDA). Such wireless local links allow mobile devices (also referred to as mobile terminals) to communicate with personal computers (PCs) such as laptops, notebooks, workstations, etc.

Today, wireless operators, such as, for example, T-Mobile, AT&T Wireless, and Verizon Wireless, which have historically provided cellular type services via WWAN networks, are now beginning to offer WLAN type services as well. By offering both WWAN and WLAN services, these operators are striving to achieve what is called converged network operations, where WWAN-WLAN services are converged. In converged networks, subscribers may want to use the same authentication data or same credentials for all services offered (e.g., WWAN and WLAN services). Unfortunately, today's certificate provisioning technologies are either WWAN specific (e.g., GSM 03.48, WPKI (Wireless Application Protocol Public Key Infrastructure)) or WLAN specific (e.g., PKI (Public Key Infrastructure)). At present, there is no integrated and seamless way to generate and provision a common user-certificate in a combined and converged WWAN-WLAN network, so that the certificate may be used for both WLAN and WWAN authentication and access.

Thus, what is needed is a system and method that allows certificate provisioning for users in a seamless manner so that the users can authenticate themselves and access services on each type of network in a combined and converged interworking network using a single credential.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate embodiments of the present invention and, together with the description, further serve to explain the principles of the invention and to enable a person skilled in the pertinent art(s) to make and use the invention. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the corresponding reference number.

FIG. **1** is a diagram illustrating an exemplary system for providing user certificate initiation, distribution, and provisioning in a converged WWAN-WLAN interworking network according to an embodiment of the present invention.

FIG. **2** is an action flow diagram illustrating an exemplary method for providing user certificate initiation, distribution, and provisioning in a converged WWAN-WLAN interworking network according to an embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

While the present invention is described herein with reference to illustrative embodiments for particular applications, it should be understood that the invention is not limited thereto. Those skilled in the relevant art(s) with access to the teachings provided herein will recognize additional modifications, applications, and embodiments within the scope thereof and additional fields in which embodiments of the present invention would be of significant utility.

Reference in the specification to "one embodiment", "an embodiment" or "another embodiment" of the present invention means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearance of the phrases "in one embodiment" and "in an embodiment" appearing in various places throughout the specification are not necessarily all referring to the same embodiment.

Embodiments of the present invention are directed to a system and method for providing user certificate initiation, distribution, and provisioning in a converged WWAN-WLAN interworking network. This is accomplished by transferring a public key generated on a personal computing device to a mobile device, and then having the mobile device send the public key to a cellular network operator infrastructure for certification. A certificate incorporating the public key is then distributed to the mobile device and the personal computing device to enable a subscriber to be authenticated when using the WWAN-WLAN services on the converged network via the mobile device or the personal computing device. Applications may also use the certificate and key pair for digital signature, verification, and encryption purposes. The certificate may also enable mutual authentication.

Thus, embodiments of the present invention allow the computing device in the converged WWAN-WLAN interworking network to play a major role in provisioning the user certificate. Having a seamless certificate generation and provisioning method extends the scope of wireless subscriber certificates outside the WWAN network into the WLAN network to SIM (Subscriber-Identity-Module), USIM (UMTS (Universal Mobile Telephone System) SIM), or RUIM (Removable User Identity Module) computing devices as well as computing devices without SIMs, USIMs, or RUIMs. Support of non-cellular devices, such as laptops, notebooks, and other computing devices is essential for WLAN access where the computing device is a more convenient platform than a cellular device (e.g., more memory, larger screen).

Although embodiments of the present invention are described for use in a converged WWAN-WLAN interworking network, the invention is not limited to converged WWAN-WLAN interworking networks. One skilled in the relevant art(s) would know that embodiments of the invention may be equally applicable to other types of networks that may be converged today or in the future to form an interworking network.

FIG. **1** is a diagram illustrating an exemplary system **100** for providing user certificate initiation, distribution, and provisioning in a converged WWAN-WLAN interworking network according to an embodiment of the present invention. System **100** comprises a WWAN network **102** and a WLAN network **104**. Both WWAN network **102** and WLAN network **104** may be owned and operated by a single service provider, such as a telecommunications operator capable of providing WWAN services and WLAN services. WWAN network **102** comprises a mobile terminal **106** having WWAN access/support. WLAN network **104** comprises a personal computer **108** having WLAN access/support. Both WWAN network **102** and WLAN network **104** allow mobile terminal **106** and personal computer **108**, respectively, access to the Internet **124**, or other networks, such as, for example, corporate networks. In embodiments of the present invention, mobile terminal **106** and personal computer **108** are operated by the same subscriber.

Although embodiments of the present invention are described using one mobile terminal and one personal computer, one skilled in the relevant art(s) would know that a subscriber having multiple mobile terminals and/or multiple personal computers may have the user certificate distributed to each mobile terminal and/or personal computer to enable use of a single user certificate for each device used by the subscriber.

A backend infrastructure **114** for the telecommunications operator is also shown in FIG. **1**. Backend infrastructure **114** comprises, inter alia, a home location register (HLR) **116**. HLR **116** comprises a main database of permanent subscriber information for both networks **102** and **104**. HLR **116** contains pertinent user information, such as name, address, account status, preferences, etc. HLR **116** further comprises a base station controller (BSC) **118**, a home subscriber server (HSS) **120**, and a public key infrastructure (PKI) portal **122**.

BSC **118** provides control functions and physical links between a mobile services switching center (MSC) (not shown) and a base transceiver station (i.e., radio equipment) (also not shown).

HSS **120** stores new parameters in the subscriber profile related to the use of a bootstrapping function. Bootstrapping is a well known process used to securely manage information to and from remote wireless devices, such as, but not limited to, GSM 03.48. In embodiments of the present invention, bootstrapping may be used to push information, such as, for example, the public key, to HSS **120** of backend infrastructure **114** for insertion into the certificate. Bootstrapping may also be used to distribute the certificate back to mobile terminal **106** and thereafter, personal computer **108**. As previously indicated, in embodiments where a subscriber has multiple mobile terminals and/or personal computers, bootstrapping may also be used to distribute the user certificate to each mobile terminal, and thereafter, each personal computer.

PKI portal **122** comprises a collection of certificates. All of the certificates generated by telecommunications operator **114** are stored in PKI portal **122**.

Personal computer **108** comprises, inter alia, a key-pair generator **110** and a secure storage unit **112**. Personal computer **108** may be a laptop, a notebook, a workstation, or any other computing device capable of having WLAN support.

Key pair generator **110** enables personal computer **108** to play a major role in the provisioning of the user certificate. Key-pair generator **110** provides a secure and reliable way to generate a key pair. The key-pair includes both a public key and a private key. The key-pair may be generated using hardware, software, or via a smart card.

For example, the key-pair may be generated using a trusted platform module (TPM) implemented on personal computer **108**. The TPM provides hardware-based protection for the encryption and digital signature keys that secure the confidentiality of user data. The TPM protects encryption keys and platform authentication information from software-based attacks by securing them in hardware.

As previously indicated, the key-pair may also be generated using software, such as, for example CAPI (Cryptographic Application Program Interface), manufactured by Microsoft Corporation. In other embodiments, a smart card may also be used to generate the key-pair in a well-known manner. As will be discussed later, the public key portion of the key-pair is be used to generate the certificate in the converged network.

Secure storage unit **112** provides a secure means for storing the private key of the key-pair. Secure storage unit **112** also stores the certificate that is generated by backend infrastructure **114**.

System **100** also provides a wired or wireless local link **126** between mobile terminal **104** and personal computer **108** for passing data between mobile terminal **104** and personal computer **108**. Local link **126** may include wireless technologies such as, for example, Bluetooth, IrDA, or other types of wireless technologies that may be used to enable mobile terminals to communicate with personal computers. Local link **126** may also include wired technologies such as, for example, a Universal Serial Bus (USB) cable, a serial cable, an Ethernet cable, or any other cable that may be used to enable communications between a mobile terminal and a personal computer.

Embodiments of the present invention allow operators and service providers the ability to offer subscribers improved ease of use, unified billing, and use of existing network infratructures in a converged interworking network. By provisioning a single certificate for accessing WWAN and WLAN services, mobile terminals and personal computers may have a unified network authentication method. Also, mobile personal computers, such as, for example, laptops and notebooks, may be provided with the ability to roam, which has traditionally only been used by wireless phones.

To access services on either network (WWAN network **102** or WLAN network **104**), subscribers must be able to authenticate themselves as an authorized user of the network. FIG. **2** is an action flow diagram describing an exemplary method **200** for providing user certificate initiation, distribution, and provisioning in a converged WWAN-WLAN interworking network according to an embodiment of the present invention. The invention is not limited to the embodiment described herein with respect to action flow diagram **200**. Rather, it will be apparent to persons skilled in the relevant art(s) after reading the teachings provided herein that other functional action flow diagrams are within the scope of the invention. The process is described from the perspective of personal computer **108**, mobile terminal **106**, and cellular network backend infrastructure **114**. The process begins at **202**, where a secure and reliable key pair is generated on personal computer **108**. The key pair may be generated via hardware, software, or a smart card as indicated above. The private key portion of the key pair is stored in secure storage unit **112**.

In **204**, a user (i.e., subscriber) or an application may initiate the process of generating and distributing a user certificate. At **206**, a public key from the key pair is transferred from computing device **108** to mobile terminal **106** over location limited channel **126**. As indicated above, location limited channel **126** may be a wired or wireless location limited channel that enables mobile terminal **106** to communicate with computing device **108**.

At **208**, mobile terminal **106** performs a bootstrapping procedure with the cellular operator by pushing the public key to backend infrastructure **114**. The user must authorize the bootstrap operation. In one embodiment, the bootstrap operation is authorized by requiring the user to enter a personal identification number (PIN) obtained from the cellular operator into mobile terminal **106**.

The bootstrapping procedure enables backend infrastructure **114** to generate a user certificate for the public key and distribute the user certificate to mobile terminal **106** in **210**. The user certificate may be stored on mobile terminal **106** in **212**. In one embodiment, the user certificate may be installed on mobile terminal **106** via a SIM card. The storage of the user certificate on mobile terminal **106** enables WWAN authentication and access to services offered by WWAN network **102** (in **213**). In one embodiment, a certificate for the cellular operator may also be obtained and installed on the SIM card.

In **214**, the user certificate (and the cellular operator certificate, if obtained) is transferred to computing device **108** via wired or wireless channel **126**. In an embodiment where a subscriber has multiple mobile terminals **106** and/or multiple computing devices **108**, the user certificate may be distributed to the remaining mobile terminals **106** and computing devices **108** as well.

In **216**, the user certificate is installed on computing device **108**. In one embodiment, the user certificate may be installed by storing it in the trusted platform module (i.e., secure storage unit **112**). In another embodiment, the user certificate may be installed via a software-based store. In yet another embodiment, the user certificate may be installed on the user's smart card. Yet in another embodiment, the user certificate may be stored on a SIM. If the cellular operator certificate is also obtained, it may also be installed on the computing device, smart card, or SIM.

In **218**, applications may use the certificate and key pair for digital signature, verification, and/or encryption purposes. In an embodiment where the cellular operator certificate was also obtained and installed, applications may also use it when verifying digital signatures. The cellular operator certificate will also enable mutual authentication, which is well known to those skilled in the relevant art(s).

In one embodiment, a user may use the certificate to sign documents, emails, etc., to verify emails and other types of documents, to encrypt emails and other types of documents, to perform e-commerce, etc. The secure and reliable key pair may also be used to secure WLAN operations.

Although embodiments of the present invention have been described for generating and distributing a user certificate, the invention is not limited to a single user obtaining a single certificate. In embodiments of the invention, more than one user certificate may be generated and distributed to a single user as well.

Certain aspects of embodiments of the present invention may be implemented using hardware, software, or a combination thereof and may be implemented in one or more computer systems or other processing systems. In fact, in one embodiment, the methods may be implemented in programs executing on programmable machines such as mobile or stationary computers, personal digital assistants (PDAs), set top boxes, cellular telephones and pagers, and other electronic devices that each include a processor, a storage medium readable by the processor (including volatile and non-volatile memory and/or storage elements), at least one input device, and one or more output devices. Program code is applied to the data entered using the input device to perform the functions described and to generate output information. The output information may be applied to one or more output devices. One of ordinary skill in the art may appreciate that embodiments of the invention may be practiced with various computer system configurations, including multiprocessor systems, minicomputers, mainframe computers, and the like. Embodiments of the present invention may also be practiced in distributed computing environments where tasks may be performed by remote processing devices that are linked through a communications network.

Each program may be implemented in a high level procedural or object oriented programming language to communicate with a processing system. However, programs may be implemented in assembly or machine language, if desired. In any case, the language may be compiled or interpreted.

Program instructions may be used to cause a general-purpose or special-purpose processing system that is programmed with the instructions to perform the methods described herein. Alternatively, the methods may be performed by specific hardware components that contain hardwired logic for performing the methods, or by any combination of programmed computer components and custom hardware components. The methods described herein may be provided as a computer program product that may include a machine readable medium having stored thereon instructions that may be used to program a processing system or other electronic device to perform the methods. The term "machine readable medium" or "machine accessible medium" used herein shall include any medium that is capable of storing or encoding a sequence of instructions for execution by the machine and that causes the machine to perform any one of the methods described herein. The terms "machine readable medium" and "machine accessible medium" shall accordingly include, but not be limited to, solid-state memories, optical and magnetic disks. Furthermore, it is common in the art to speak of software, in one form or another (e.g., program, procedure, process, application, module, logic, and so on) as taking an action or causing a result. Such expressions are merely a shorthand way of stating the execution of the software by a processing system to cause the processor to perform an action or produce a result.

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. It will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined in the appended claims. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined in accordance with the following claims and their equivalents.

What is claimed is:

**1**. A method comprising:

generating a security key pair in a personal computer, wherein the security key pair comprises a public key and a private key, the public key stored in a secure storage of the personal computer;

sending the public key from the personal computer to a mobile terminal and sending the public key from the mobile terminal to a cellular operator;

receiving a first instance of a user certificate, from the cellular operator, at the mobile terminal;

sending a second instance of the user certificate from the mobile terminal to the personal computer;

sending a plurality of instances of the user certificate respectively from the mobile terminal to a plurality of personal computers;

utilizing the mobile terminal on a wireless wide-area network (WWAN) based on the first instance while simultaneously utilizing the personal computer on a wireless local-area network (WLAN) based on the second instance and simultaneously utilizing the plurality of personal computers on the WLAN based on the plurality of instances of the user certificate;

wherein the mobile terminal includes the first instance of the user certificate while simultaneously the personal computer includes a second instance of the user certificate and the plurality of personal computers include the plurality of instances of the user certificate;

wherein the user certificate was generated by the cellular operator based on the public key sent from the mobile terminal.

**2**. A method according to claim **1**, further comprising:

prompting a user at the mobile terminal for a personal identification number (PIN) for authentication with the cellular operator; and

receiving the PIN from the user at the mobile terminal;

wherein storing the first instance in the mobile terminal is performed after receiving the PIN from the user at the mobile terminal.

**3**. A method according to claim **1**, further comprising storing the second instance in a trusted platform module (TPM) in the personal computer.

**4**. A method according to claim **1**, further comprising:

prompting a user at the mobile terminal for a personal identification number (PIN) for authentication with the cellular operator; and

receiving the PIN from the user at the mobile terminal;

utilizing the first instance to authenticate the mobile terminal on the WWAN; and

utilizing the first instance to authenticate the user as a subscriber to the WWAN.

**5**. A method according to claim **1**, further comprising:

prompting a user at the mobile terminal for a personal identification number (PIN) for authentication with the cellular operator; and

receiving the PIN from the user at the mobile terminal;

utilizing the first instance to authenticate the mobile terminal on the WWAN;

utilizing the first instance to authenticate the user as a subscriber to the WWAN;

utilizing the second instance to authenticate the personal computer on the WLAN; and

utilizing the second instance to authenticate the user as a subscriber to the WLAN.

**6**. A method according to claim **1**, further comprising utilizing the second instance for digital signature purposes.

**7**. A method according to claim **1**, wherein the mobile terminal comprises a mobile device capable of cellular telephone communications.

**8**. A method according to claim **1**, wherein the user certificate includes the public key.

**9**. A method according to claim **1**, wherein neither of the personal computer and the mobile terminal have been authenticated before sending the public key from the mobile terminal to a cellular operator.

**10**. At least one non-transitory storage medium having instructions stored thereon for causing a system to perform operations comprising:

generating a security key pair in a first computing node, the security key pair comprising a public key and a private key;

sending the public key from the first computing node to a mobile second computing node;

sending the public key from the second computing node to a cellular operator network;

receiving a second instance of a user certificate, from the cellular operator network, at the second computing node;

sending a first instance of the user certificate from the second computing node to the first computing node;

sending a plurality of instances of the user certificate respectively from the second computing node to a plurality of computing nodes;

simultaneously utilizing (a) the second computing node on a wireless wide-area network (WWAN) based on the second instance, (b) the first computing node on a wireless local-area network (WLAN) based on the first instance, and (c) the plurality of computing nodes on the WLAN based on the plurality of instances;

wherein simultaneously the first computing node includes the first instance, the second computing node includes the second instance, and the plurality of computing nodes includes the plurality of instances;

wherein the second instance was generated by the cellular operator based on the public key sent.

**11**. The at least one non-transitory storage medium of claim **10**, the operations comprising:

prompting a user at the second computing node for a personal identification number (PIN) for authentication with the cellular operator; and

receiving the PIN from the user at the second computing node;

wherein storing the second instance in the second computing node is performed after receiving the PIN from the user at the second computing node.

**12**. The at least one non-transitory storage medium of claim **10**, the operations comprising storing the first instance in a trusted platform module (TPM) in the first computing node.

**13**. The at least one non-transitory storage medium of claim **10**, the operations comprising:

prompting a user at the second computing node for a personal identification number (PIN) for authentication with the cellular operator; and

receiving the PIN from the user at the second computing node;

utilizing the second instance to authenticate the second computing node on the WWAN;

utilizing the second instance to authenticate the user as a subscriber to the WWAN;

utilizing the first instance to authenticate the first computing node on the WLAN; and

utilizing the first instance to authenticate the user as a subscriber to the WLAN.

**14**. At least one non-transitory storage medium having instructions stored thereon for causing a system to perform operations comprising:

sending a public key from a first computing node (node) to a cellular operator network;

receiving an instance of a user certificate, from the cellular operator network, at the first node;

sending a plurality of instances of the user certificate from the first node to a plurality of nodes;

simultaneously utilizing (a)(i) the first node on a wireless wide-area network (WWAN) based on the instance, and (a)(ii) a first plurality of the plurality of nodes on a wireless local-area network (WLAN) based on the plurality of instances;

wherein simultaneously the first node includes the instance while the plurality of nodes include the plurality of instances.

**15**. The at least one non-transitory storage medium of claim **14**, the operations comprising receiving the public key at the first node from one of the plurality of nodes.

**16**. The at least one non-transitory storage medium of claim **15**, wherein the instance was generated by the cellular operator based on the public key sent.

**17**. The at least one non-transitory storage medium of claim **14**, the operations comprising simultaneously utilizing (b)(i) the first node on the WWAN based on the instance, (b)(ii) the first plurality of the plurality of nodes on the WLAN based on the plurality of instances, and (b)(iii) a second plurality of the plurality of nodes on the WWAN based on the plurality of instances.

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